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RESEARCH ARTICLE

Health status of the field protective forest belts in Dobrudzha – results from the monitoring carried out in 2022

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Abstract

In 2022, the health status of the field protective forest belts on the territory of the State Hunting Enterprise Balchik and State Forest Enterprises General Toshevo and Dobrich was monitored. The assessment of tree crown condition covered 7069.3 ha (66% of all field protective belts in Bulgaria). The results showed that 70% of monitored belts were in good condition, 23% - in moderate condition, and 7% - in poor condition. Since 2014 the area of the protective forest belts in poor condition has increased 2.6 times, and 76% of them were situated in Dobrudzha region. Ash belts – *Fraxinus excelsior* (66% of all belts) and *Fraxinus americana* (10%) were in the worst conditon. In ash belts a process of crown dieback, premature falling of leaves and drying of whole trees were observed. In individual ash belts, drying reached up to 80% of tree crowns, regardless of their age and origin. The drying was mostly due to the biotic factors – insect pests and fungal pathogens. The protective forest belts of *Quercus cerris, Q. petraea, Q., rubra and Gleditschia triacanthos* stand out as sustainable tree species. It is necessary to significantly upgrade the methodology by which the monitoring of the health status of trees in the field protective forest belts is currently carried out. In the new methodology a detailed description of the type of data that need to be collected, the methods of assessments, and data reporting formats, have to be included.

Keywords
Protective forest belts, forest management, monitoring of health status, deterioration of ash belts, Dobrudzha

Introduction

In the Dobrudzha region field protective forest belts (FPFBs) were created in the 1950s to protect agricultural areas from wind erosion, to improve the soil moisture storage, and to increase the agricultural crop yields (Marinov et al., 2003; Vassilev et al., 2019). The major goal of the protective forest management is to ensure efficient and effective protective functions of the belts over a long period (Brang et al., 2006). Since their creation, the management practices of forest belts in the Dobrudzha region have been associated with some threats – a lack of experience and expertise, steppe growth conditions, decline of health status of several tree species, security problems, regulatory weaknesses, etc. (Dodev et al., 2023a,b).

The field protective forest belts were created as reclamation facilities (Georgiev, 1960). To fulfil their main purpose, the planted trees in the belts have to be in good physiological and healthy condition, and to have a blown construction (Pamfilov, 1936; Byallovich, 1939; Matyakin, 1948). However, in the last decades, the protective forest belts in Bulgaria have declined due to various reasons. In 2002, a large number of the FPFBs deteriorated in their condition. The application of differentiated approaches for their management according to their condition was proposed (Marinov et al., 2003).

The appropriate health status of the forest belts is the prerequisite for carrying out their protective functions efficiently. Tree deterioration is one of the most important indicators that function as a notification system to maintain forest sustainability (Fuller, Quine, 2016). Since 2020, a serious deterioration of the health status of ash (*Fraxinus* spp.) forest belts has been observed in the Dobrudzha region (Mateva, Kirilova, 2021). The largest affected areas were located on the territory of the State Hunting Enterprise (SHE) Balchik and State Forest Enterprises (SFEs) General Toshevo and Dobrich (Mateva, Kirilova, 2022).

The field protective forest belts planted with *Robinia pseudoacacia* L. gradually degraded due to the repeated clear-cuttings for shoot regeneration (Dodev et al., 2023a). Severe dying of *Ulmus minor* Mill. trees, caused by Dutch elm disease (*Ohiostoma novo-ulmi*) was detected. Dodev et al. (2023a) pointed out some mistakes in the management of the *Gleditschia triacanthos* L. protective forest belts and the need for new afforestations because of the belts' deterioration.

In 2014, the Executive Forest Agency (EFA) at the Ministry of Agriculture, Food and Forests issued executive Guidelines for the management of FPFBs. According to them, the forest belts have to be monitored annually to determine the health condition and suitability for carrying out protecting functions efficiently. The purpose of this study was to analyse the results of the monitoring carried out in 2022 on the

health status of the field protective forest belts from different tree species in the SHE Balchik, SFEs General Toshevo and Dobrich.

Objects and methods

This study summarises and analyses the results of the monitoring of health status conducted at the end of May 2022 in the FPFBs on the territory of SHE Balchik, SFEs General Toshevo and Dobrich. The monitored area covered 7069.3 ha (SHE Balchik – 2694.9 ha; SFE General Toshevo – 2783.8 ha; and SFE Dobrich – 1590.6 ha), which was over 66% of all FPFBs in Bulgaria.

The monitoring included a visual assessment by local foresters applying the EFA Guidelines (2014) for management of FPFBs. According to their health status, the belts were differentiated into three categories, as follows:

- good health status – the scheme of forest belts was the same as when they were created; there were no symptoms indicating deterioration (dieback in crowns, frost cracks, cankers on the stems, etc.), the degree of defoliation was up to 25%; the belts fulfilled their purpose.

- moderate health status – crown dieback was up to 30%, the degree of defoliation was up to 60%, occurrence of frost crakes and canker formations; belts had a partially impaired functionality.

- poor health status – as a result of maturity, fires, abiotic, biotic, and other factors, the main species was missing or was up to 50% in tree composition; the degree of defoliation was over 60%, dieback was over 30%; the belt was not fulfilling its functionality.

The monitoring results for the three State Enterprises were kindly provided by the EFA in MS Excel documents. The belts were allocated according to the main tree species' health status, the degree of damage, etc. The comparison of the area of FPFBs in poor health was analysed on the basis of the forest plans in 2014 (SFE General Toshevo and Dobrich) and 2015 (SHE Balchik), and the monitoring implemented in 2022.

Results and discussion

In 2022, the total area of the field protective forest belts in poor health in Bulgaria was 645.2 ha. Over 70% of them were located in the SHE Balchik, and in the SFEs General Toshevo and Dobrich. The largest area of the most deteriorated belts was distributed in SFE Dobrich; 34% of all belts in the country had a poor health status. In the other two monitored enterprises, this area was about 137 ha, or approximately 21% of all belts in the country. The highest percentage (85%) of belts in good health was distributed in the SHE Balchik.

The monitored FPFBs in the SHE Balchik and SFEs General Toshevo and Dobrich were allocated according to the assessment of their health status in 2022 (Table 1). The data showed that the predominant proportion (58-85%) of the belts were in good health, and only 5-14% showed poor health status.

Table 1. Allocation of the field protective forest belts according to their health status (2022)

State Forest/Hunting Enterprise	Good		Moderate		Poor		Total
	ha	(%)	ha	(%)	ha	(%)	ha
Balchik	2291.7	(85)	266.7	(10)	136.5	(5)	2694.9
General Toshevo	1736.2	(62)	910.1	(33)	137.5	(5)	2783.8
Dobrich	929.1	(58)	442.6	(28)	218.9	(14)	1590.6
Total (Average %)	4957.0	(70)	1619.4	(23)	492.9	(7)	7069.3

In recent years, a tendency for deterioration of the health status in the FPFBs in Dobrudzha has been obvious and the degradation processes have proceeded relatively quickly. Since 2014-2015, the area of the belts in poor condition increased from 186.2 to 492.9 ha (Fig. 1). The strongest deterioration was registered in the SFE Dobrich – from 15.2 ha (2014) to 218.9 ha (2022). Decline of trees, dieback in crowns and premature leaf drop prior to autumn were noticed.

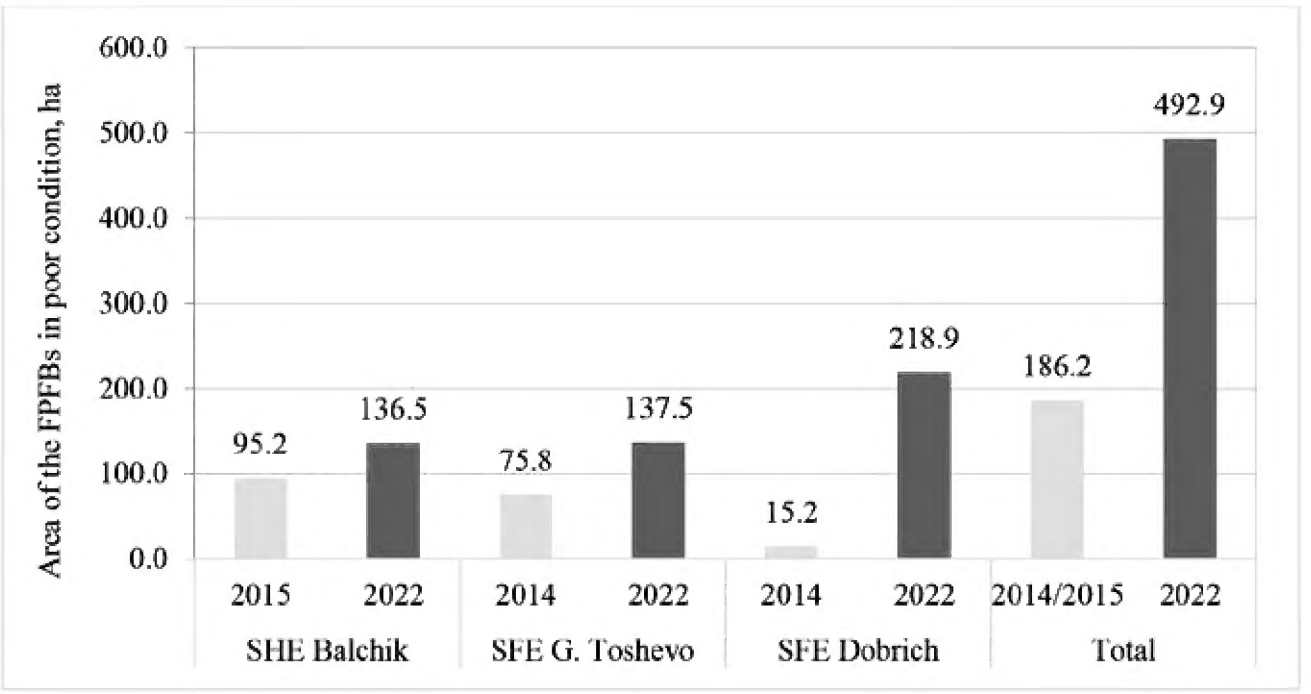

Figure 1. Area (ha) of the field protective forest belts in poor health status for the period 2014-2022

The allocation of the area of the FPFBs in the worst health status according to the main tree species in the three monitored State Enterprises, showed that the degradation processes most strongly affected the ash forest belts (*Fraxinus excelsior* L., *F.*

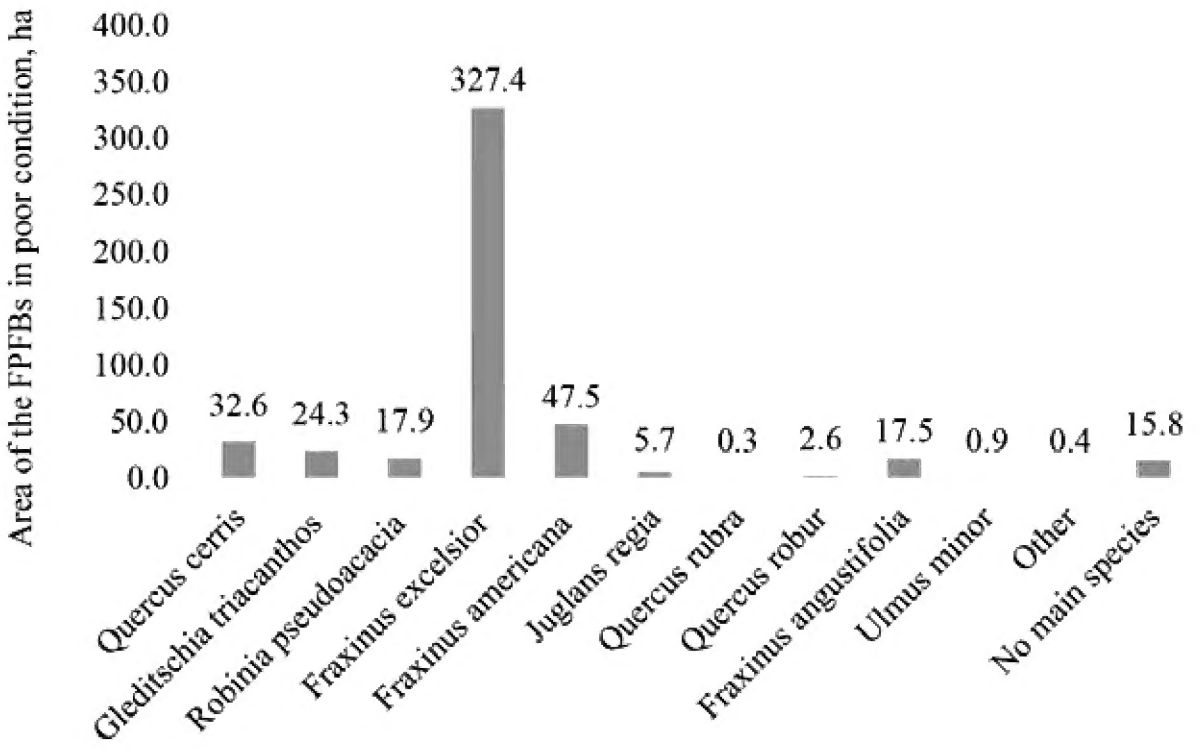

Figure 2. Allocation of the area of the FPFBs in poor condition by main tree species

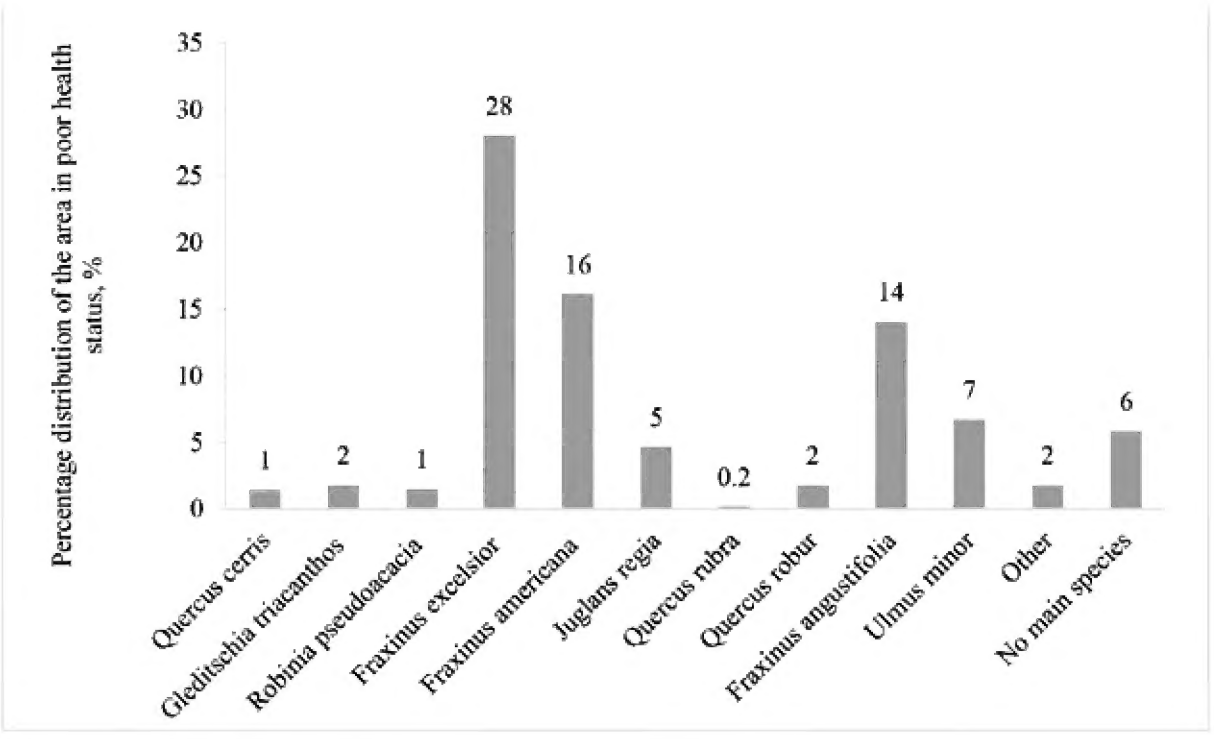

Figure 3. Relative share of FPFB in poor condition for different tree species compared to their total area

americana L., and *F. angustifolia* Vahl.) with an area of 375.8 ha that was more than 76% of all belts in poor condition in the studied region (Fig. 2).

The area of the belts in poor health status was greatest in *F. excelsior* (66.4%), followed by *F. americana* (9.6%). In *F. angustifolia*, this area of declined belts was negligible (less than 0.2%). In *F. excelsior* and *F. americana* the processes of dieback, premature leaf fall and drying of whole trees were found.

The strongest deterioration of the health status was reported for *F. excelsior* (28% of the FPFB were in poor condition), followed by *F. americana* (16%) and *Ulmus minor* Mill. (14%) (Fig. 3). Less affected were the belts of *F. angustifolia* (7%), *Juglans regia* L. (5%), as well as those in which the main tree species were not present or had a reduced participation (6%). The most resistant tree species were *Quercus cerris* L., *Q. robur* L., *Q. rubra* L. and *Gleiditschia triacanthos* L., where the proportion of belts in poor condition was below 2% (Fig. 3).

The results of the monitoring showed that the belts plated with *Robinia pseudoacacia* L. were in good health status. Dodev et al. (2023), however, point out that after the second shoot rotation, the height, vitality and stability of the *R. pseudoacacia* belts greatly decrease, which practically makes them unfit to fulfil their main purpose.

The most damaged were the ash forest belts on the territory of the SFE Dobrich that were more than 60% of all studied ash belts. In SHE Balchik and SFE General Toshevo, their percentage was lower – 15% and 13%, respectively, but there was a tendency for intensive deterioration of their health condition. In 2021, six totally dry ash belts were cut in SHE Balchik. Logging was also expected in many other belts in poor condition.

The distribution of the area of FPFB *F. excelsior* according to their age (for their total number and for those in poor health), showed that the two curves completely overlap, as all age groups were equally affected (Fig. 4). There was no difference in the health status between the belts with seed and shoot origin. This indicated that ash dying was likely due to a combination of predisposing stress factors and opportunistic biotic factors (insect pests or fungal pathogens).

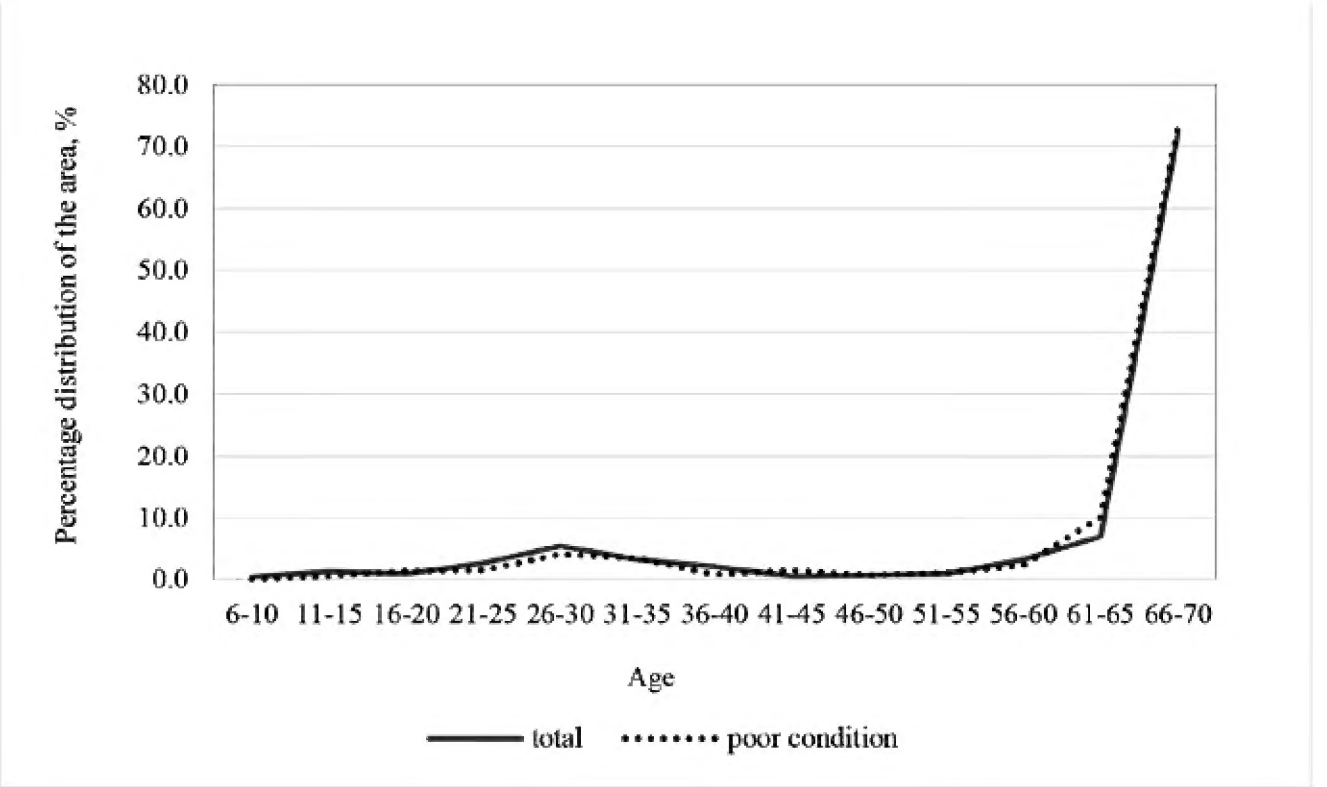

Figure 4. Age distribution of the area of the *Fraxinus excelsior* FPFBs (total number and in poor condition)

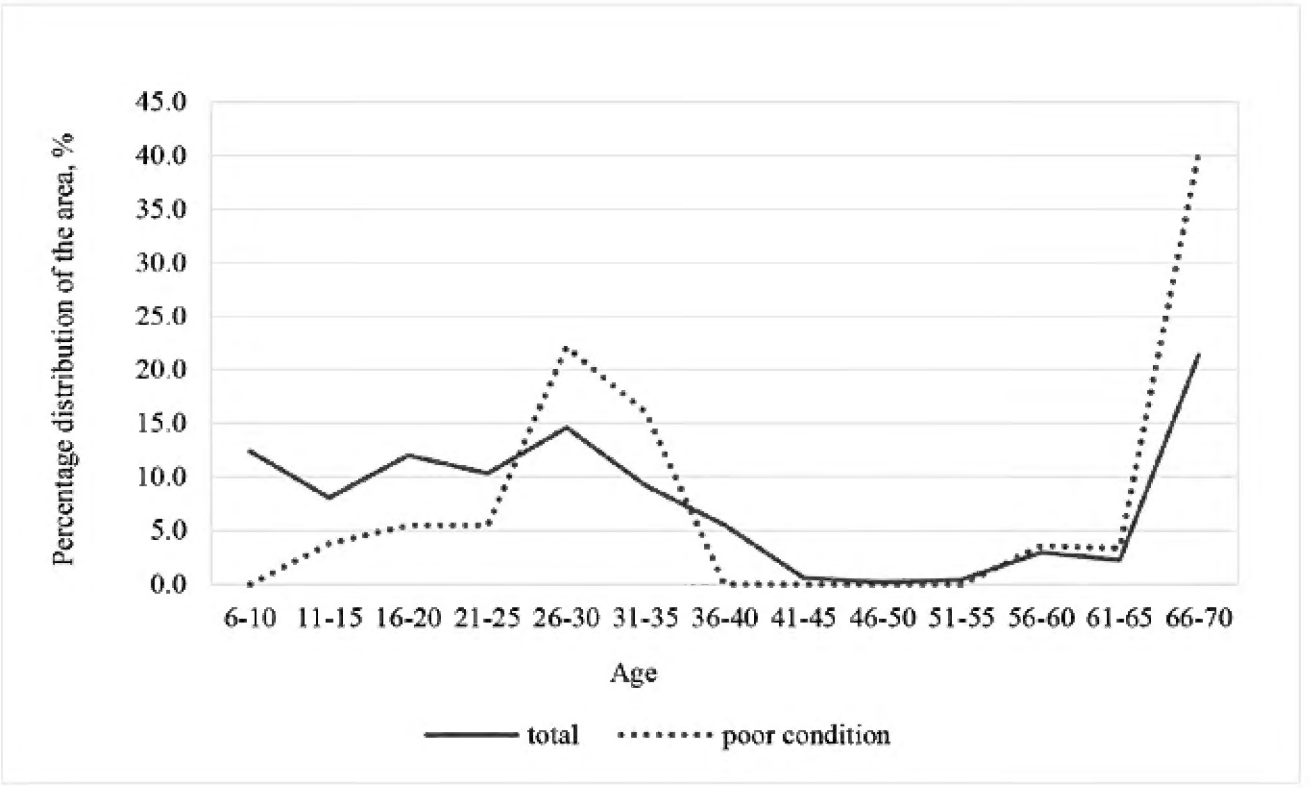

Figure 5. Age distribution of the area of the *Fraxinus americana* FPFBs (total number and in poor condition)

The situation was similar for *F. americana*, where the degree of damage increased with increasing age (Fig. 5). An explanation for this could be the fact that this introduced tree species was not suitable for the ecological conditions in Dobrudzha and with increasing age it weakened physiologically to a greater extent.

Currently, *Fraxinus angustifolia* showed a higher resistance to both environmental conditions and biological factors as pests and diseases. Its health deterioration was much lower than *F. excelsior* and *F. americana*. The results from the monitoring in 2022 revealed that only 0.9 ha of *F. angustifolia* forest belts were in poor health status (Fig. 2).

Deterioration of the health status of ash trees was also observed earlier in northeastern Bulgaria. Rosnev and Petkov (1994) reported that until 1985-1987 the ash forest plantations were in a good health condition, but in 1987-1990 a process of continuous and increasing drying of individual branches and trees began. In the region of the SFEs Novi Pazar and Dobrich, the drying rate in one year (1988-1989) increased from 24% to 37%, which was a critical moment for their forest management. Fungal pathogens *Cytophoma pulchelia* (Sace) Guthn., *Endoxilina astroideae* Fr., *Daldinia* sp. and *Citospora* sp., which causes necrosis on the trees' stems and branches, were established. Currently, a potential threat to ash trees has been the fungal pathogen *Chalara fraxinea* Kowalski, which was established in many European countries, including in Romania (Drenkhan, Hanso, 2010).

Diseases and pests were observed not only on ash trees, but also on other tree species in the FPFB. Masse dying of *Ulmus minor* forest belts due to Dutch elm disease (*Ophiostoma novo-ulmi* Brasier), was observed in the Dobrudzha region. The most

dangerous insect pest in oak forests, *Lymantria dispar* (L.) (Lepidoptera: Erebidae), periodically causes complete defoliation of *Quercus cerris* L. forest belts (Zlatanov, 1970). It should be noted, however, that there has been a lack of modern targeted and in depth studies on the health status of FPFBs and the specific abiotic and biotic factors causing the drying of trees in them.

The presence of a system of wind generators for the production of electricity in some regions of northeastern Bulgaria (Balchik, Kavarna, Shabla, etc.) makes it difficult to apply traditional methods of control the main insect pests in the FPFBs by using aviation equipment. In this regard, it is necessary to expand the participation of established biological methods in the future development of integrated control systems. In 2021, the species-specific entomopathogenic fungus *Entomophaga maimaiga* Humber, Shimazu et Soper (Entomophthorales: Entomophthoraceae) was used to control the gypsy moth (*Lymantria dispar*) population in the FPFB in the Balchik region (Georgiev et al., 2021, 2023).

It is also possible to use remote-sensing methods to assess the health status of FPFB through spectral analysis of drone or satellite images, which have been successfully applied to analys es of green settlement systems (Dimitrov et al., 2018), natural forest stands (Dimitrov et al., 2019; Belilov et al., 2022; Georgiev et al., 2022a,b) and forest plantations (Georgieva et al., 2022).

Conclusions

The deterioration of the health status of the field protective forest belts in the Dobrudzha region has developed with high intensity on large areas. The forest protective belts of ash (*Fraxinus* spp.) and *Ulmus minor* were in the worst health status. These belts should be gradually regenerated by planning reforestation activities. In the FPFBs with moderate health status, preventive work should be done to improve and maintain their condition and functions. For this purpose, it is necessary to develop a comprehensive methodology for a complex assessment of the state of the FPFBs.

It is necessary to significantly upgrade the methods by which the monitoring of the health status of trees in the field protective forest belts is currently carried out. In the new methodology a detailed description of the type of data that need to be collected, the methods of assessments, and data reporting formats, have to be included. In addition to the health status of the FPFBs, it is necessary to evaluate in detail their essential structural-functional characteristics that determine the capacity of the belts fulfil their main purpose. The new methodology should be implemented in practice and used to conduct the annual monitoring of the FPFBs and to prepare analytical reports on their condition, and plan the necessary forestry activities in them.

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